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Editorial

Planning and Operation of Electrical Energy Systems under Uncertainties

Marcos Tostado-Véliz [1,*], Salah Kamel [2] and Abd Elnaby Kabeel [3,4]

[1] Department of Electrical Engineering, University of Jaén, EPS Linares, 23700 Jaén, Spain
[2] Department of Electrical Engineering, Faculty of Engineering, Aswan University, Aswan 81542, Egypt; skamel@aswu.edu.eg
[3] Faculty of Engineering, Delta University for Science and Technology, Gamasa 7731168, Egypt; kabeel6@f-eng.tanta.edu.eg
[4] Mechanical Power Engineering Department, Tanta University, Tanta 31527, Egypt
* Correspondence: mtostado@ujaen.es

1. Introduction

The electricity sector is evolving dramatically. To achieve carbon neutrality by 2050, key sectors are implementing notable changes in order to properly integrate renewable energy sources (RESs). In this context, the widescale integration of RESs such as photovoltaic (PV) and wind sources will be crucial and necessary.

In order to properly manage the integration of such resources, traditional planning and operation tools must be revisited, in order to face the challenges brought with the new technologies and agents incorporated to a system. One of the critical aspects to consider is the intermittent and unpredictable behaviour of some RESs, but demand profiles are also evolving, thus leading to more unpredictable patterns [1].

2. Planning and Operation of Electrical Energy Systems under Uncertainties

In this regard, the development of proper tools capable of working under uncertain conditions is a necessity for the industry, being crucial for the optimal operation of the system but also the proper planning of upcoming frameworks such as energy communities or microgrids [2,3]. This Special Issue incorporates research on some of the most recent advances in this field. A total of 12 papers were submitted, and 7 were accepted (58.3% acceptance rate), demonstrating notable interest in this research area among the scientific community.

Some of the accepted papers focus on traditional power systems and conventional tools such as the optimal power flow (OPF). This tool was first studied in the early 1980s, but the incorporation of uncertainties poses a challenge for traditional methodologies which have been used in previous decades. Thus, Alghamdi [4] developed a novel technique for OPF based on the Firefly Jaya algorithm, considering uncertainties in PV and wind generation. On the other hand, the paper of Ali et al. [5] explores stochastic-based approaches. More specifically, this work discusses a methodology that can be used to reduce the original scenario space to render it tractable by average computers.

One key concept regarding future energy systems is the integration of different energy vectors and their central management. In this way, synergies among different carriers such as electricity, gas, or water can be optimally leveraged. In this context, the author of [6] proposes an efficient energy management methodology for the economic and environmental operation of integrated wind–solar–thermal systems based on the search optimization algorithm. Likewise, ref. [7] focuses on the concept of an energy hub, for which an optimal scheduling strategy is developed. Energy hubs are small-scale sub-networks in which different energy carriers are integrated and conversion technologies are dispatched in a centralized way.

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Another important point to take into account in terms of planning tools for renewable-based systems is the proper modelling of such renewable sources, particularly their components. In this sense, the estimation of some important parameters is challenging. Such is the case of PV panels, for which different estimation methodologies have been proposed in the literature [8]. In this regard, Memon et al. [9] developed an estimation technique for unknown parameters in PV panel modelling based on the cheetah optimizer.

Finally, the economic planning of microgrids is investigated in the paper of Wang et al. [10]. In this study, the treatment of nonlinear optimization models, besides the computational burden of planning problems, was circumvented using a metaheuristic technique. The paper of Praveenkumar et al. [11] is a review work, in which the main barriers for the implantation of concentrating solar installations in India are identified.

3. Future Challenges and Perspectives

This Special Issue covers some of the most important research topics in the optimal planning of electricity systems under uncertainty. Nevertheless, we anticipate further and comprehensive works in this field. For example, local market mechanisms for energy communities or microgrid clusters are expected to play a vital role in the efficient operation of such sub-systems [12]. Such problems become challenging under uncertainties, for which optimal game-based methodologies are expected to emerge in the near future.

Conflicts of Interest: The authors declare no conflict of interest.

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